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IS 7318-2 (1974): Approval Tests for Welders when Welding Procedure Approval is not Required, Part II: Tig or Mig Welding of Aluminium and its Alloys [MTD 11: Welding General]



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Indian Standard

APPROVAL TESTS FOR WELDERS
WHEN WELDING PROCEDURE APPROVAL
IS NOT REQUIRED

PART II TIG OR MIG WELDING OF
ALUMINIUM AND ITS ALLOYS

(Third Reprint AUGUST 1997)

UDC 621.791.754 : 669.71 : 658.386

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

APPROVAL TESTS FOR WELDERS WHEN WELDING PROCEDURE APPROVAL IS NOT REQUIRED

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Indian Standard

APPROVAL TESTS FOR WELDERS WHEN WELDING PROCEDURE APPROVAL IS NOT REQUIRED

PART II TIG OR MIG WELDING OF ALUMINIUM AND ITS ALLOYS

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 30 December 1974, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard is one of a series of Indian Standards on the approval testing of welders and welding procedures, the latter having a bearing on the former for certain applications. This link has been used as a means of arranging the series of standards into :

- a) Approval tests for welding procedures,
- b) Welder approval when welding procedure approval is required, and
- c) Welder approval when the welding procedure is not required to be approved (for either technical or contract reasons).

The simple approval of welders on sheet, plate and pipe* when no welding procedure approval is required is covered by this standard. Part I covers fusion welding of steel while this part covers TIG and MIG welding of aluminium and its alloys. For the purposes of this standard, welders are considered to have already received training in the welding of aluminium and its alloys.

0.3 To complete the philosophy behind this series of standards, it is considered useful to give details of the practices relating to welding procedure approval even though they are not strictly relevant to this standard. Depending upon the emphasis placed on quality control in the production of welded components, so may the approval of welding procedures be administered in one of several ways which should be stipulated at the enquiry and/or order stage.

The alternatives currently employed are the following :

- a) Each individual contractor (or sub-contractor) may have proved by actual test pieces every weld form he wishes to use, in every thickness and material;

*In this standard the word 'pipe', alone or in combination, is used to mean 'pipe' or 'tube' or 'structural hollow section' (circular or rectangular), although these terms are often used for different categories of product by different industries.

or

- b) Each individual contractor (or sub-contractor) may have proved by actual test pieces, a set of welds representative on a group basis, of all the various thicknesses and materials to be used in production;

or

- c) Each individual contractor (or sub-contractor) need not make procedure test pieces providing he can prove by appropriate authentic documentation of an independent nature that he has previously welded the type of joint and material in question satisfactorily.

In respect of (a) and (b) it should be appreciated that once the welding procedure tests have been approved, they need never be repeated unless there is a change in certain variables. As an extension beyond (c), it may be possible in the future for fully documented welding procedures, developed independently of the particular contractor, to be employed without the need for further approval tests.

0.4 In the preparation of this standard assistance has been derived from draft British Standard, Doc : 73/43577DC 'Specification for approval testing of welders when welding procedure approval is not required. Part 2 TIG or MIG welding of aluminium and its alloys' issued by the British Standards Institution.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part II) specifies requirements for the approval testing of welders to be engaged on the TIG or MIG welding of those aluminium and aluminium alloy fabrications for which the welding procedure does not itself have to be approved.

NOTE — This link to the non-mandatory approval of the welding procedure will result in the use of this standard becoming defined more closely in respect of the particular fabrication, for example, with regard to material, thickness, joint configuration.

2. INFORMATION TO BE GIVEN TO THE WELDER

2.1 The welder shall be provided with written instructions and information covering the following details :

- a) Parent metal (Alloy type and condition).
- b) Welding process.

*Rules for rounding off numerical values (*revised*).

- c) Welding consumables (filler material specification and diameter; composition and approximate flow rate of shielding gas, purging gas, if any).
- d) For TIG welding the electrode diameter and type.
- e) Welding position.
- f) Metal thickness and, for pipe, the outside diameter or dimension.
- g) Pre-weld cleaning.
- h) Joint type, with sketch of weld preparation.
- j) Weld dimensions required.

Other factors shall be left to the choice of the welder but the relevant details shall be recorded (*see also 4*).

3. TEST WELDS*

3.1 General — The welder shall make the test weld, or welds selected from the tests in **3.3** to **3.14**, which is/are most representative of the type of work on which he will be employed. The welder shall make a further test weld, or welds, whenever the work on which he will be employed changes sufficiently in respect of the items listed in **2** and as specified for the relevant test, to make the test weld, or welds, on which he has already obtained approval no longer representative of the new work.

Where tack welds are used their location shall be identifiable after the test weld has been completed. This will help to check whether failure in the region of tack weld is due to defective tack weld. Distortion or misalignment caused by tacking may be corrected before the test weld is made.

3.2 Parent Metal — For the purpose of this standard, parent metals have been grouped as shown in Table 1. The approval of a welder to weld a particular type of material shall include approval for all the other materials in the same group in Table 1. Approval between groups of materials is not permitted.

TABLE 1 GROUPING OF PARENT METALS

GROUP NUMBER	PARENT METAL ACCORDING TO IS : 733-1967*, IS : 734-1967†, ETC
1	1, 1A, 1B, 1C, NS3
2	H19, H20, H30
3	N4, N5, NS51, N8
4	H17

*Specification for wrought aluminium and aluminium alloys, bars, rods, and sections (for general engineering purposes) (*first revision*).

†Specification for wrought aluminium and aluminium alloys, forgings stock and forgings (for general engineering purposes) (*first revision*).

*The test welds given in this standard permit the use of whatever sizes of material are readily available. The types of joint, however, are not necessarily the same as those that are met in practice.

3.3 Test 1 — Butt Weld in Sheet (Without Permanent Backing)

3.3.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 2, provided that the test conditions listed have been met.

TABLE 2 BUTT WELD IN SHEET (WITHOUT PERMANENT BACKING)

	TEST CONDITION	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (see 3.2), welding process and welding consumables of types used for the test
Welding position*	Flat	Flat
	Vertical-up	Vertical-up and flat
	Vertical-up and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
Thickness, t	3 mm, Max	$0.75 t - 1.5 t$
Joint type	Square butt as in Fig. 1	a) Any butt weld without permanent backing in sheet in above thickness range b) Fillet welds in the above thickness range

*If a combination of test positions other than those specified is used, the welder is approved only for that combination.

3.3.2 Deposition of Test Weld — The test weld shall be stopped and restarted within the central 50 mm of its length.

A sealing run on the reverse side is not permitted.

3.4 Test 2 — Fillet Weld in Sheet

3.4.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 3, provided that the test conditions listed have been met.

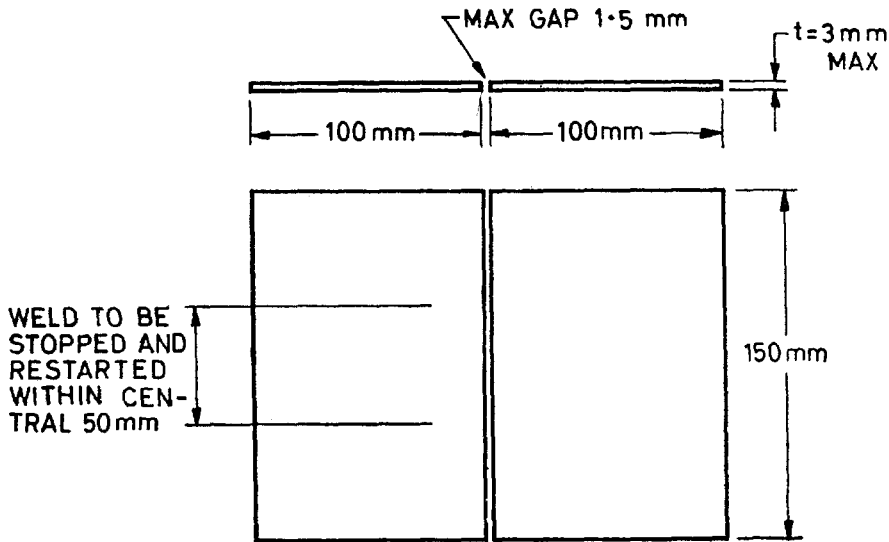


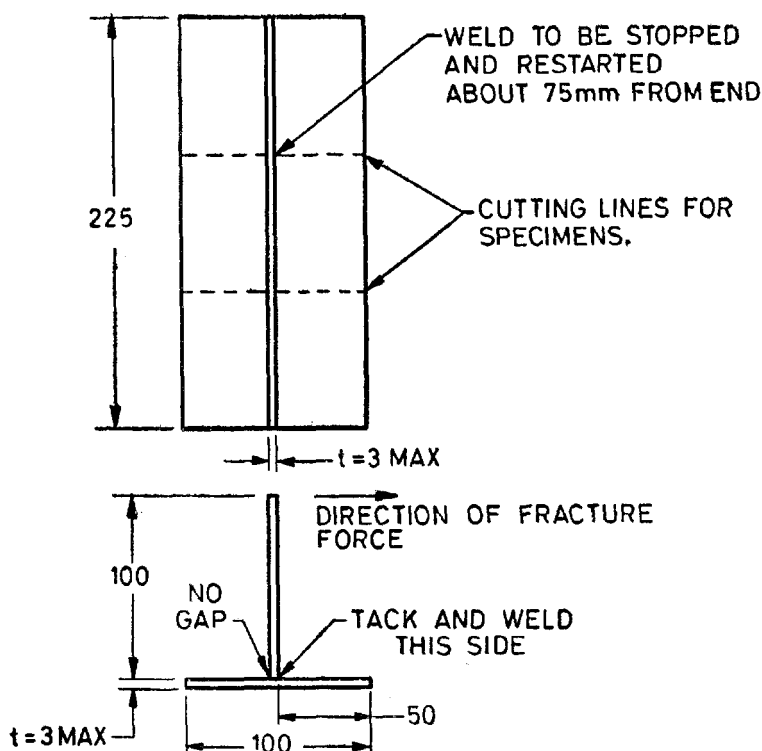
FIG. 1 TEST PIECE FOR BUTT WELD IN SHEET
(WITHOUT PERMANENT BACKING)

TABLE 3 FILLET WELD IN SHEET
(Clause 3.4.1)

	TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (see 3.2), welding process and welding consumables of types used for the test
Welding position*	Horizontal-vertical	Horizontal-vertical and flat
	Vertical-up	Vertical-up, horizontal-vertical and flat
	Overhead	Overhead, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
Thickness, t	3 mm, Max	$0.75 t - 1.5 t$ (In the case of a combination of unequal thicknesses this applies to thinner of the two thicknesses.)
Joint type	T joint as in Fig. 2	Any fillet weld in sheet in above thickness range

*If a combination of test positions other than those specified is used, the welder is approved only for that combination.

3.4.2 Deposition of Test Weld — The test weld shall be made in a single run on only one side of the joint, with equal leg lengths of approximately 4 mm. The weld shall be stopped and restarted at about 75 mm from one end.



All dimensions in millimetres.

FIG. 2 TEST PIECE FOR FILLET WELD IN SHEET

3.5 Test 3 — Butt Weld in Plate (without Backing, Welded from One Side)

3.5.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 4, provided that the test conditions listed have been met.

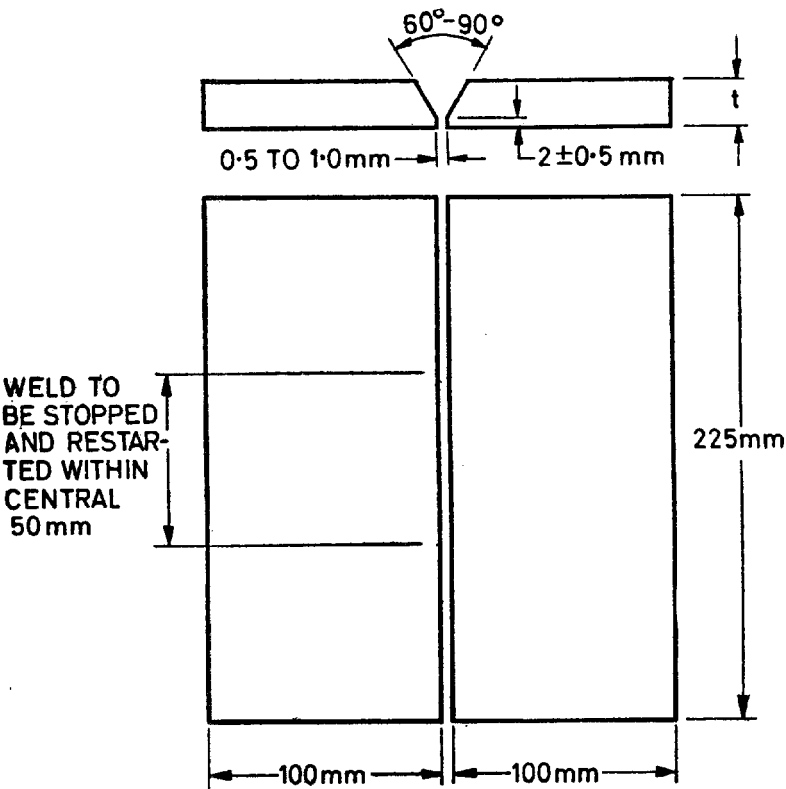
**TABLE 4 BUTT WELD IN PLATE (WITHOUT BACKING,
WELDED FROM ONE SIDE)**

	TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (<i>see 3.2</i>), welding process and welding consumables of types used for the test
Welding position*	Flat	Flat
	Vertical-up	Vertical-up and flat
	Vertical-up and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
Thickness, t	At least 6 mm, but less than 12 mm	$0.75 t - 1.5 t$
	12 mm or thicker	8 mm and thicker
Joint type	Single-V butt, without backing, as in Fig. 3†	For plate in above thickness ranges: a) Any single sided butt weld preparation, with or without temporary backing, welded from one side only b) Any single sided butt weld preparation welded from both sides without back gouging c) Any double sided butt weld preparation d) Fillet weld

*If a combination of test positions other than those specified, is used, the welder is approved only for that combination.

†The dimensions of the weld preparation are typical for welding in the flat position but for other positions it may be necessary for modifications to be made. In all cases the details shall be recorded (*see 2 and Appendix A*).

3.5.2 Deposition of Test Weld — Each run of the test weld shall be stopped and restarted within the central 50 mm of its length.



NOTE — See 3.5.1 for plate thickness 't'.

FIG. 3 TEST PIECE FOR BUTT WELD IN PLATE
(WITHOUT BACKING, WELDED FROM ONE SIDE)

3.6 Test 4 — Butt Weld in Plate (Welded from Both Sides)

3.6.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 5, provided that the conditions listed have been met.

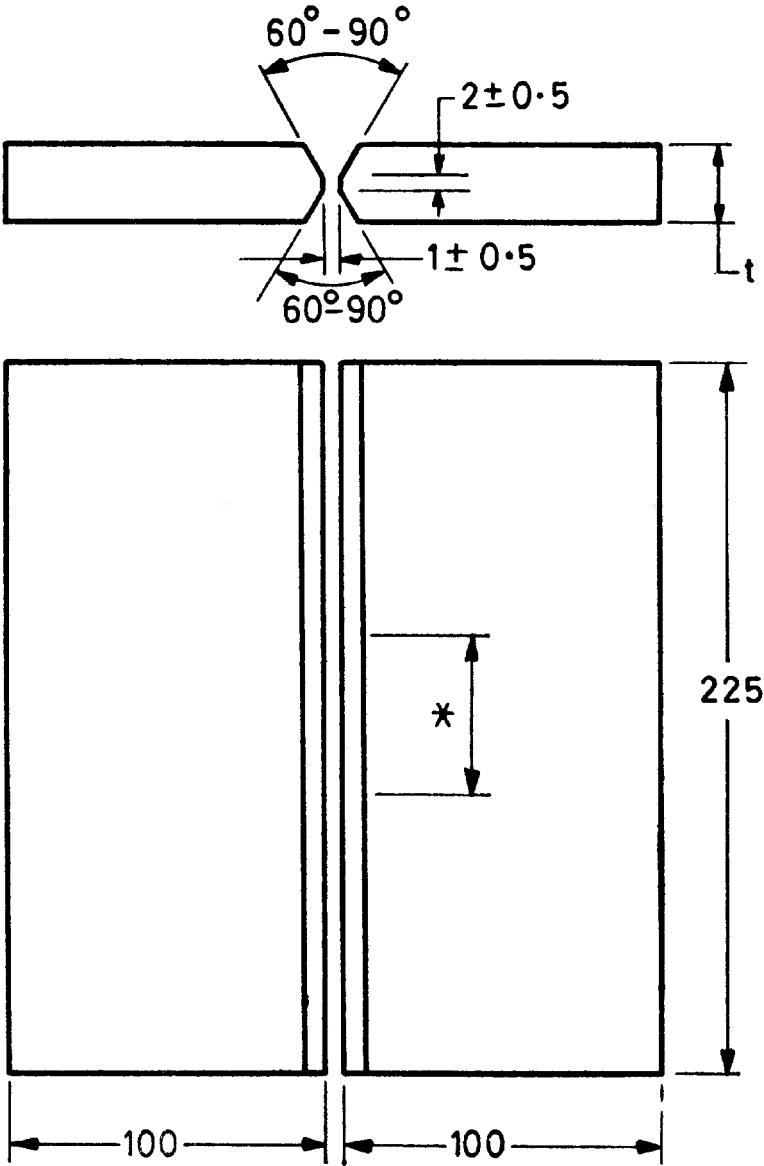
TABLE 5 BUTT WELD IN PLATE (WELDED FROM BOTH SIDES)

	TEST CONDITIONS		APPLICABILITY OF TEST
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2		Only material group (see 3.2), welding process and welding consumables of types used for the test
Welding position*	First side	Second side	
	Flat	Overhead	Flat, overhead, horizontal-vertical
	Vertical-up	Vertical-up	Vertical-up and flat
	Vertical-up (double operator)	Vertical-up (double operator)	Vertical-up (double operator) and flat
	Vertical-up	Vertical-up	Vertical-up, horizontal-vertical and flat
	Horizontal-vertical	Horizontal-vertical	
	Vertical-up	Vertical-up	Vertical-up, overhead, flat and horizontal-vertical
	Overhead	Flat	
Thickness, t	At least 6 mm, but less than 12 mm		0.75 t –1.5 t
Joint type	Double-V butt as in Fig. 4†		For plate in above thickness ranges: 1) Any double sided butt weld preparation 2) Any single sided butt weld preparation welded from both sides with back gouging

*If a combination of test positions other than those specified is used, the welder is approved only for that combination.

†The dimensions of the weld preparation are typical for welding in the flat and overhead positions, but for other positions it may be necessary for modifications to be made. In all cases the details shall be recorded (see 2 and Appendix A).

3.6.2 Deposition of Test Weld — Each run of the test weld shall be stopped and restarted within the central 50 mm of its length.



*** WELD TO BE STOPPED AND
RESTARTED WITHIN CENTRAL 50 mm**

All dimensions in millimetres.
NOTE — See 3.6.1 for plate thickness ' t '.

**FIG. 4 TEST PIECE FOR BUTT WELD IN PLATE
(WELDED FROM BOTH SIDES)**

The back of the first run shall be chipped-out by suitable means to clean sound metal before welding is started on the chipped-out side, except where the 'double operator' technique is used in the vertical-up position.

The dimensions of the weld preparation are typical for welding in the flat and overhead positions, but for other positions it may be necessary for modifications to be made; for example, in the 'double operator' technique in the vertical-up position a wider gap and sighting notches may be used. In all cases the details shall be recorded (*see* 2 and Appendix A).

3.7 Test 5 — Butt Weld in Plate (with Permanent Backing)

3.7.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 6 provided that the test conditions listed have been met.

TABLE 6 BUTT WELD IN PLATE (WITH PERMANENT BACKING)

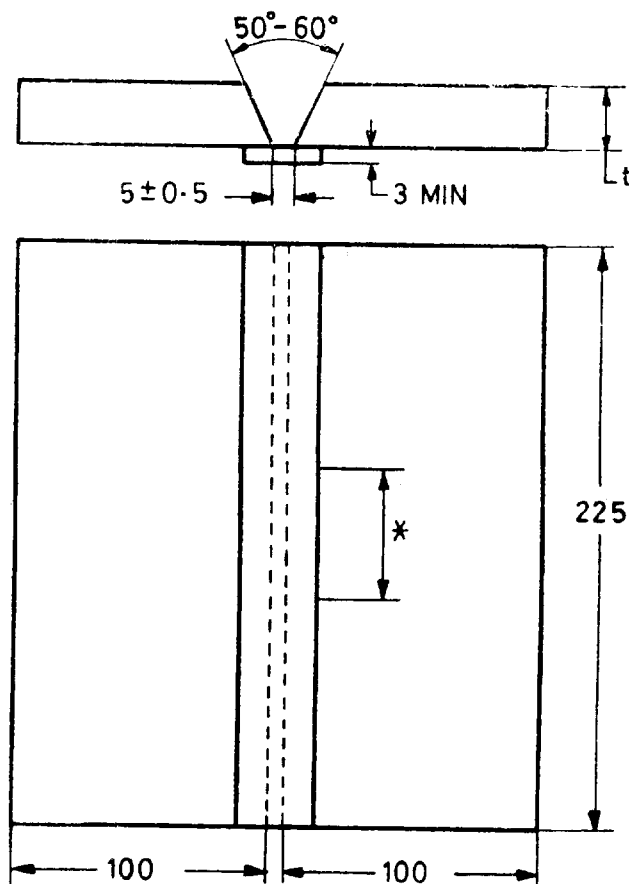
		TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables		As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (<i>see</i> 3.2), welding process and welding consumables of types used for the test
Welding position*		Flat	Flat
		Vertical-up	Vertical-up and flat
		Vertical-up and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
		Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
Thickness, <i>t</i>		At least 3 mm, but less than 12 mm	0.75 <i>t</i> –1.5 <i>t</i>
		12 mm or thicker	8 mm and thicker
Joint type		Square or single-V butt, with backing, as in Fig. 5† according to process and thickness	Any single sided butt weld preparation with permanent backing in plate in above thickness ranges

*If a combination of test positions other than those specified is used, the welder is approved only for that combination.

†The dimensions of the weld preparation are typical for manual welding in the flat position but for other positions it may be necessary for modifications to be made. In all cases the details shall be recorded (*see* 2 and Appendix A).

3.7.2 Deposition of Test Weld — Each run of the test weld shall be stopped and restarted within the central 50 mm of its length.

The dimensions of the weld preparation are typical for welding in the flat position but for other positions it may be necessary for modifications to be made. In all cases the details shall be recorded (*see* 2 and Appendix A).



* WELD TO BE STOPPED AND
RESTARTED WITHIN CENTRAL 50 mm

All dimensions in millimetres.

NOTE 1 — *See* 3.7.1 for plate thickness 't'.

NOTE 2 — TIG welding all thickness.
MIG welding 6 mm and thicker.

NOTE 3 — For MIG welding plate less than 6 mm thick a square edge preparation may be used.

**FIG. 5 TEST PIECE FOR BUTT WELD IN PLATE
(WITH PERMANENT BACKING)**

3.8 Test 6 — Butt Weld in Plate (with Temporary Backing)

3.8.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 7, provided that the test conditions listed have been met.

TABLE 7 BUTT WELD IN PLATE (WITH TEMPORARY BACKING)

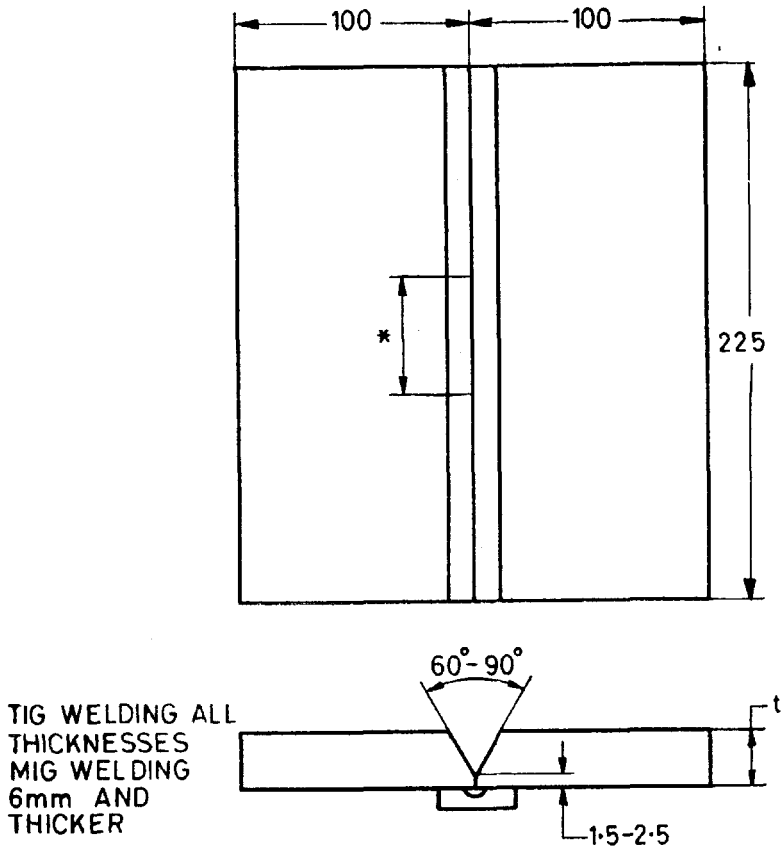
	TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (see 3.2), welding process and welding consumables of types used for the test
Welding position*	Flat	Flat
	Vertical-up	Vertical-up and flat
	Vertical-up and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
Thickness, t	At least 3 mm, but less than 12 mm	0.75 t –1.5 t
	12 mm or thicker	8 mm and thicker
Joint type	Square or single-V butt with backing, as in Fig. 6† according to process and thickness	Any single sided butt weld preparation with temporary backing in plate in above thickness ranges

*If a combination of test positions other than those specified is used, the welder is approved only for that combination.

†The dimensions of the weld preparation are typical for manual welding in the flat position but for other positions it may be necessary for modifications to be made. In all cases the details shall be recorded (see 2 and Appendix A).

3.8.2 Deposition of Test Weld — Each run of the test weld shall be stopped and restarted within the central 50 mm of its length.

The dimensions of the weld preparation are typical for welding in the flat position but for other positions it may be necessary for modifications to be made. In all cases the details shall be recorded (see 2 and Appendix A).



* WELD TO BE STOPPED AND
RESTARTED WITHIN CENTRAL 50mm

All dimensions in millimetres.

- NOTE 1 — See 3.8.1 for plate thickness 't'.
NOTE 2 — For MIG welding of plate less than 6 mm thick only a sighting 'V' may be necessary.

FIG. 6 TEST PIECE FOR BUTT WELD IN PLATE
(WITH TEMPORARY BACKING)

3.9 Test 7 — Fillet Weld in Plate

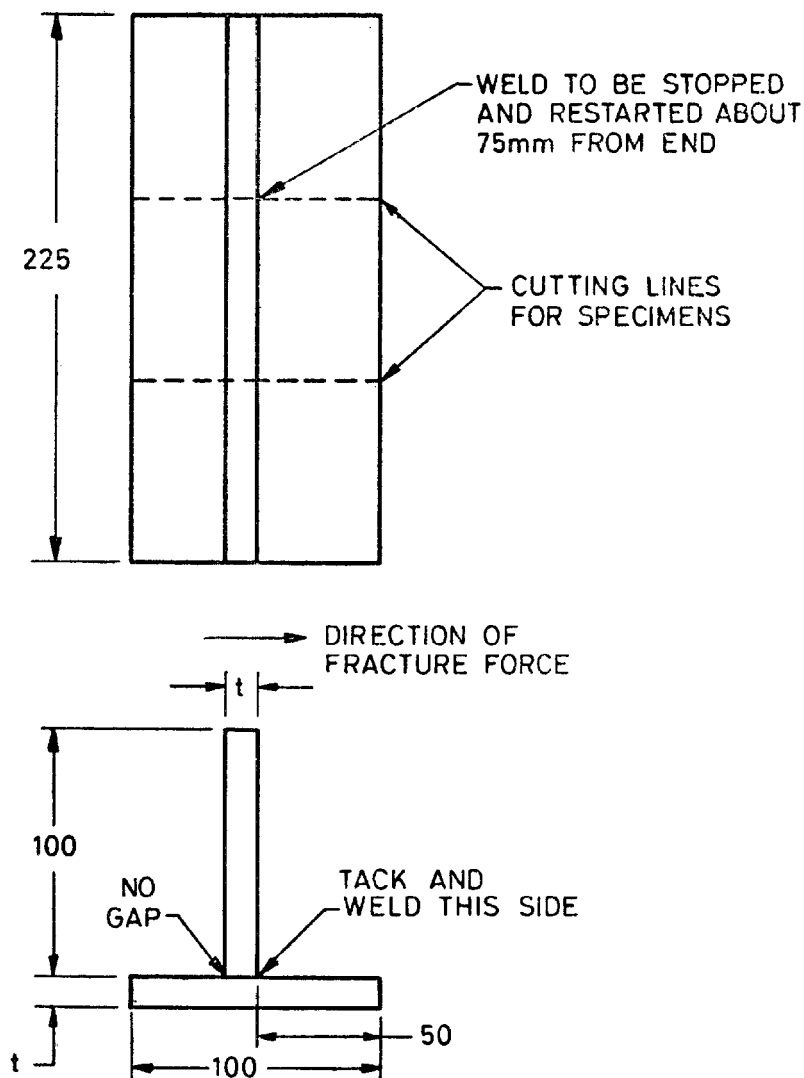
3.9.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 8, provided that the test conditions listed have been met.

TABLE 8 FILLET WELD IN PLATE

	TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (<i>see</i> 3.2), welding process and welding consumables of types used for the test
Welding position*	Horizontal-vertical	Horizontal-vertical and flat
	Vertical-up	Vertical-up, horizontal-vertical and flat
	Overhead	Overhead, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
Thickness, t	At least 6 mm, but less than 12 mm	0.75 t –1.5 t (In the case of a combination of unequal thicknesses this applies to thinner of the two thicknesses)
	12 mm or thicker	8 mm and thicker
Joint type	T joint as in Fig. 7	Any fillet weld in plate in above thickness ranges

*If a combination of test positions other than those specified is used, the welder is approved only for that combination.

3.9.2 Deposition of Test Weld — The test weld shall be made on only one side of the joint, with equal final leg lengths corresponding to approximately the thickness, t . Each run shall be stopped and restarted at about 75 mm from one and the same end.



All dimensions in millimetres.

NOTE — See 3.9.1 for plate thickness ' t '.

FIG. 7 TEST PIECE FOR FILLET WELD IN PLATE

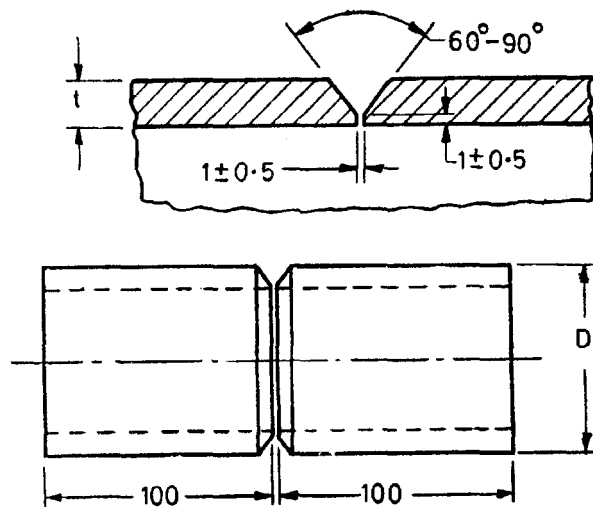
3.10 Test 8 — Butt Weld in Pipe (without Backing)

3.10.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 9, provided that the test conditions listed have been met.

TABLE 9 BUTT WELD IN PIPE (WITHOUT BACKING)

		TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables		As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (see 3.2), welding process and welding consumables of types used for the test
Position*	Pipe positions	Axis horizontal — pipe rotating	Flat
		Axis horizontal — pipe fixed (vertical-up)	Overhead, vertical-up and flat
		Axis vertical	Horizontal-vertical and flat
		Axis inclined at 45° — pipe fixed (vertical-up) or Axis horizontal — pipe fixed (vertical-up) and axis vertical (2 test welds)	Overhead, vertical-up, horizontal-vertical and flat
Thickness, t		Less than 6 mm	0.75 t –1.5 t
		6 mm or thicker	4 mm and thicker
Outside diameter or dimension D (for rectangular hollow sections D is dimension of smaller side)		Less than 165 mm	0.5 D –1.5 D
		165 mm or larger	80 mm and larger
Joint type		Single-V butt without backing, as in Fig. 8	For pipe in above thickness and diameter ranges: 1) Any butt weld in pipe, with or without backing 2) Any branch joint with a hole in the main pipe

*If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.



All dimensions in millimetres.

NOTE 1 — See 3.10.1 for dimensions ' t ' and ' D '.

NOTE 2 — For pipe less than 3 mm thick a square edge preparation may be used.

FIG. 8 TEST PIECE FOR BUTT WELD IN PIPE
(WITHOUT BACKING)

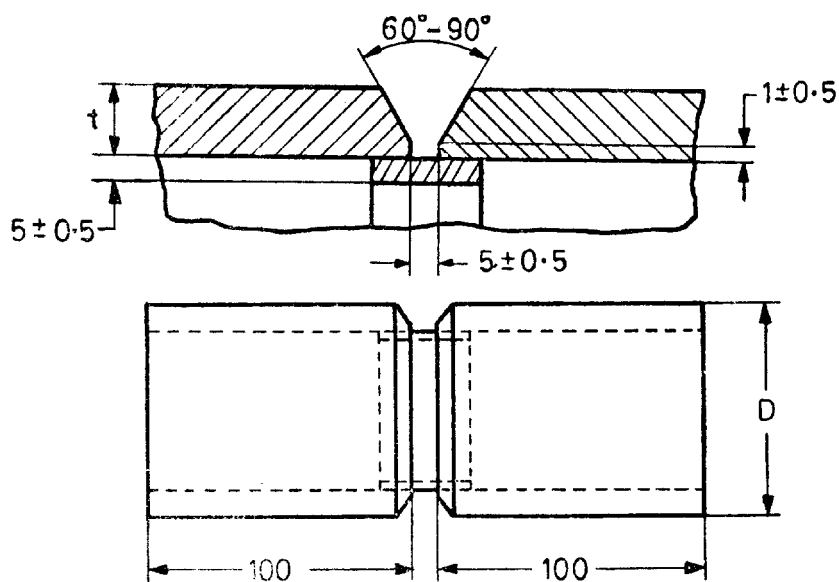
3.11 Test 9 — Butt Weld in Pipe (with Permanent Backing)

3.11.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 10, provided that the test conditions listed have been met.

TABLE 10 BUTT WELD IN PIPE (WITH PERMANENT BACKING)

		TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables		As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (<i>see 3.2</i>), welding process and welding consumables of types used for the test
Position*	Pipe positions	A x i s horizontal — pipe rotating	Flat
		A x i s horizontal — pipe fixed (vertical-up)	Overhead, vertical-up and flat
		Axis vertical	Horizontal-vertical and flat
		Axis inclined at 45° — pipe fixed (vertical-up) or Axis horizontal — pipe fixed (vertical-up) and axis vertical (2 test welds)	Overhead, vertical-up, horizontal-vertical and flat
Thickness, <i>t</i>		Less than 6 mm	0.75 <i>t</i> – 1.5 <i>t</i>
		6 mm or thicker	4 mm and thicker
Outside diameter or dimension <i>D</i> (for rectangular hollow sections <i>D</i> is dimension of smaller side)		Less than 165 mm	0.5 <i>D</i> – 1.5 <i>t</i>
		165 mm or larger	80 mm and larger
Joint type		Single-V butt with backing, as in Fig. 9	Any butt weld with permanent backing in above thickness and diameter ranges

*If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.



All dimensions in millimetres.

NOTE — See 3.11.1 for dimensions 't' and 'D'.

FIG. 9 TEST PIECE FOR BUTT WELD IN PIPE
(WITH PERMANENT BACKING)

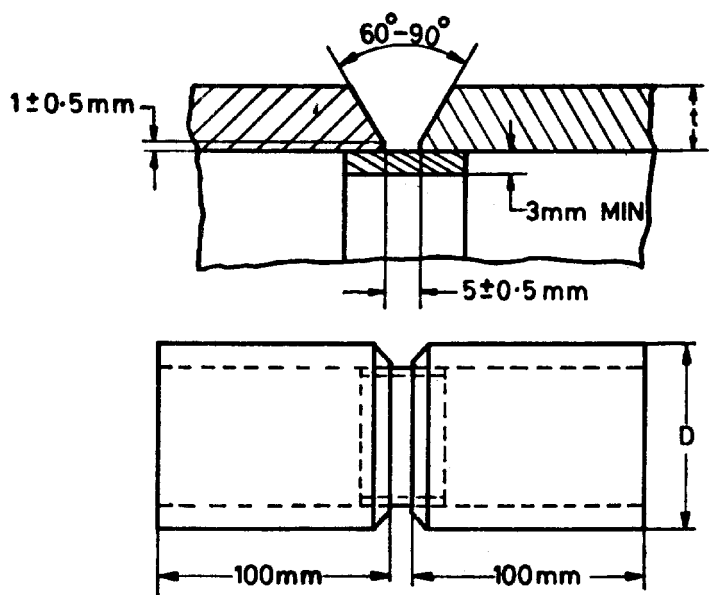
3.12 Test 10 — Butt Weld in Pipe (with Temporary Backing)

3.12.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 11, provided that the test conditions listed have been met.

TABLE 11 BUTT WELD IN PIPE (WITH TEMPORARY BACKING)

		TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables		As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (see 3.2), welding process and welding consumables of types used for the test
Position*	Pipe positions	Axis horizontal — pipe rotating	Flat
		Axis horizontal — pipe fixed (vertical-up)	Overhead, vertical-up and flat
		Axis vertical	Horizontal-vertical and flat
		Axis inclined at 45° — pipe fixed (vertical-up) or Axis horizontal — pipe fixed (vertical-up) and axis vertical (2 test welds)	Overhead, vertical-up, horizontal-vertical and flat
Thickness, t		Less than 6 mm	0.75 t –1.5 t
		6 mm or thicker	4 mm and thicker
Outside diameter or dimension D (for rectangular hollow sections D is dimension of smaller side)		Less than 165 mm	0.5 D –1.5 D
		165 mm or larger	80 mm and larger
Joint type		Single-V butt with backing, as in Fig. 10	Any butt weld with temporary backing in above thickness and diameter ranges

*If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.



NOTE — See 3.12.1 for dimensions of 't' and 'D'.
FIG. 10 TEST PIECE FOR BUTT WELD IN PIPE
(WITH TEMPORARY BACKING)

3.13 Test 11 — Fillet Weld in Pipe (Branch Joint for Structural Applications)

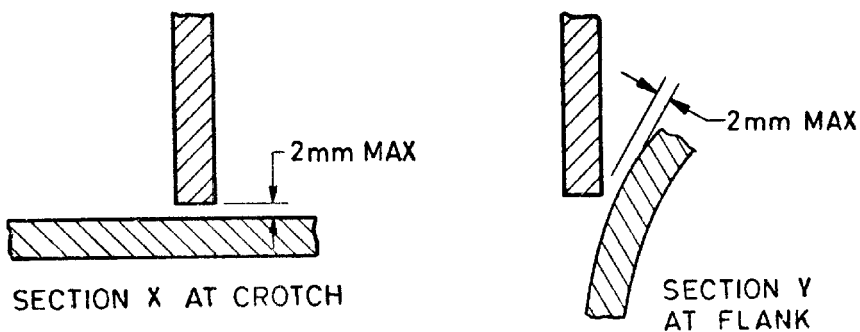
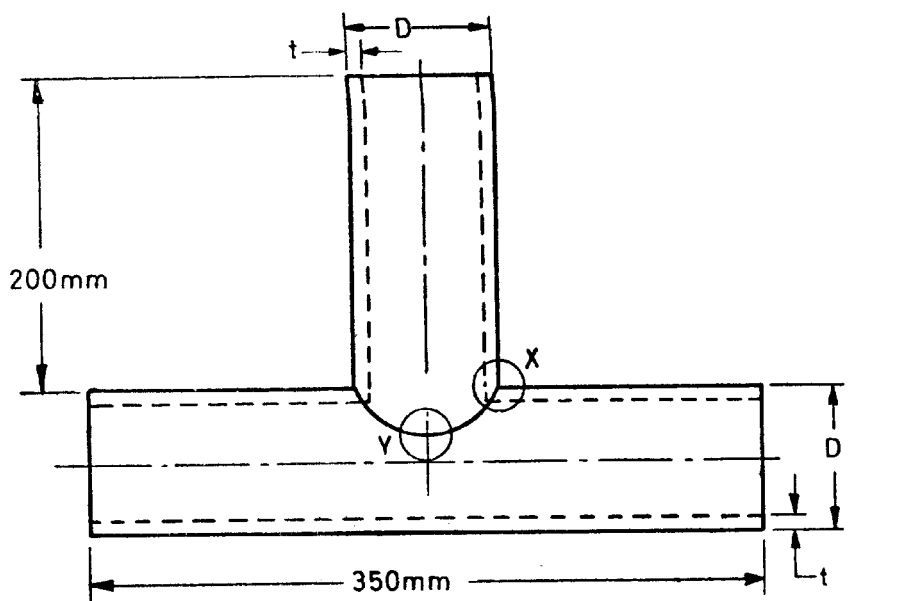
3.13.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 12, provided that the test conditions listed have been met.

TABLE 12 FILLET WELD IN PIPE (BRANCH JOINT FOR STRUCTURAL APPLICATIONS)

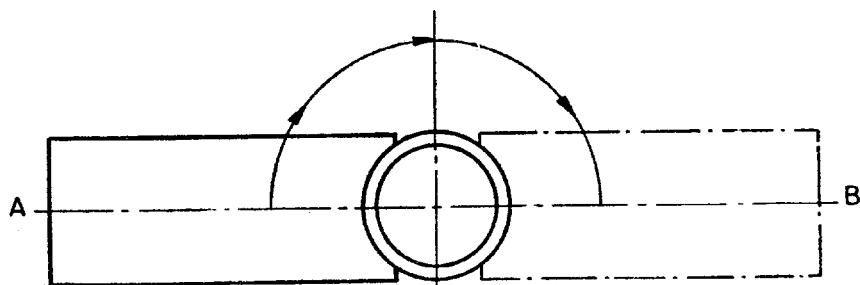
		TEST CONDITIONS	APPLICABILITY OF TEST
Parent metal, welding process and welding consumables		As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (<i>see</i> 3.2), welding process and welding consumables of types used for the test
Position*	Pipe positions	Axis of main and branch horizontal — fixed during welding but branch turned through 180° (vertical-up) [<i>see</i> Fig. 11 (B)]	Vertical-up, horizontal-vertical and flat
		Axis of main horizontal, axis of branch vertical-fixed	Flat, horizontal-vertical, and overhead
		Axis of main and branch horizontal — fixed (vertical-up)	Overhead, vertical-up, horizontal-vertical and flat
Thickness, t		Less than 6 mm	0.75 t –1.5 t
		6 mm or thicker	4 mm and thicker
Outside diameter or dimension D (for rectangular hollow sections D is dimension of smaller side)		Less than 165 mm	0.5 D –1.5 D
		165 mm or larger	80 mm and larger
Joint type		Right angle branch as in Fig. 11(A)	Any fillet weld in pipe in above thickness and diameter ranges for structural applications

*If a combination of test pipe positions other than those specified is used, the welder approved for the welding positions derived only from that combination.

3.13.2 Deposition of Test Weld — The test weld shall change gradually from a fillet weld at the crotch to a butt weld at the flank. The fillet weld at the crotch shall have equal leg lengths corresponding to approximate the thickness, t , or 4 mm whichever is the greater.



(A) JOINT CONFIGURATION



FIRST HALF OF EACH RUN DEPOSITED IN POSITION A,
RUN COMPLETED IN POSITION B

(B) MAIN AND BRANCH HORIZONTAL, BRANCH TURNED THROUGH 180°

NOTE — See 3.13.1 for dimensions of 't' and 'D'.

FIG. 11 TEST PIECE FOR FILLET WELD IN PIPE
(BRANCH JOINT FOR STRUCTURAL APPLICATIONS)

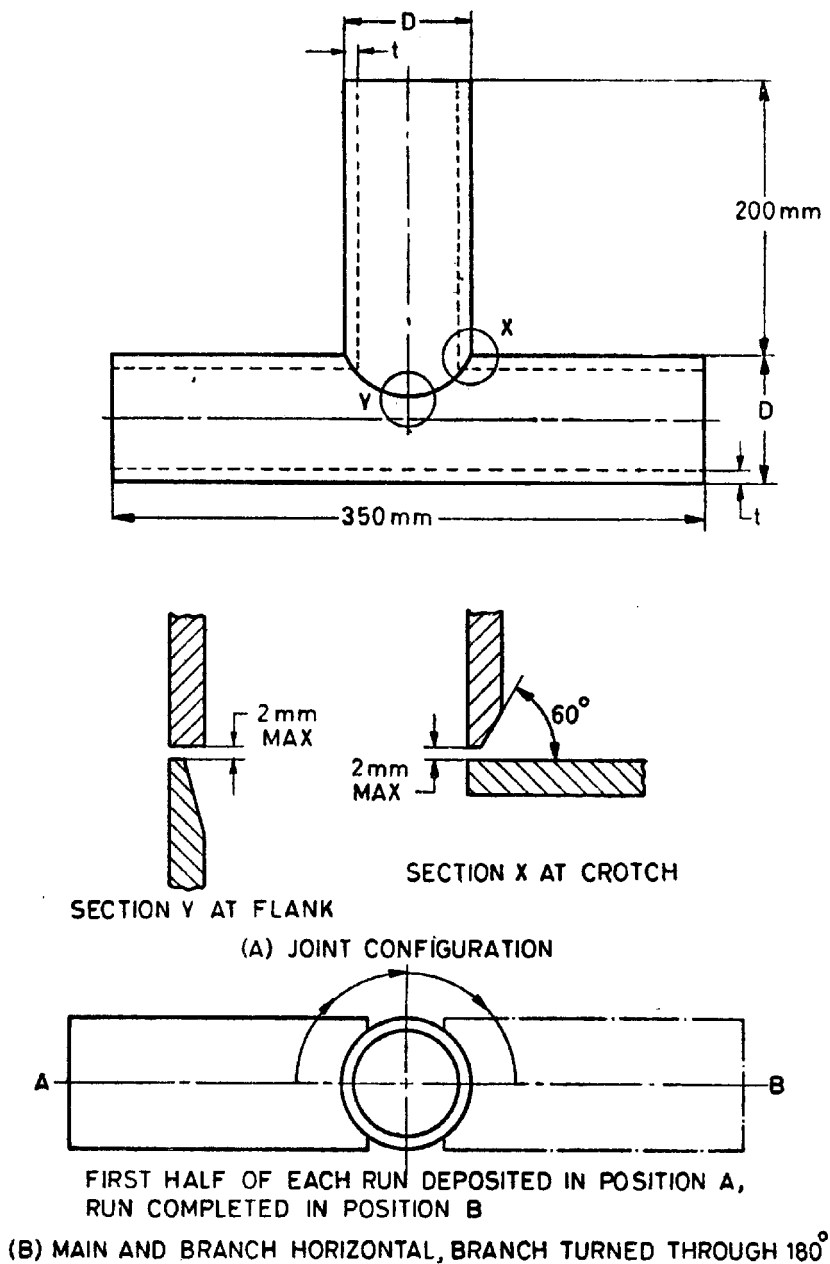
3.14 Test 12 — Fillet Weld in Pipe (Branch Joint for Pressure Applications)

3.14.1 Applicability of Test and Test Conditions — The applicability of this test shall be as given in Table 13, provided that the test conditions listed have been met.

TABLE 13 FILLET WELD IN PIPE (BRANCH JOINT FOR PRESSURE APPLICATIONS)

TEST CONDITIONS		APPLICABILITY OF TEST
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with 2	Only material group (see 3.2), welding process and welding consumables of types used for the test
Position*	<div>Pipe positions</div> <div>Axis of main and branch horizontal — fixed during welding but branch turned through 180° (vertical-up) [see Fig. 12 (B)]</div>	Vertical-up, horizontal-vertical and flat
	<div>Welding positions</div> <div>Axis of main horizontal, axis of branch vertical — fixed</div>	Flat, horizontal-vertical, and overhead
	Axis of main and branch horizontal — fixed (vertical-up)	Overhead, vertical-up, horizontal-vertical and flat
Thickness, t	Less than 6 mm	$0.75 t - 1.5 t$
	6 mm or thicker	4 mm and thicker
Outside diameter or dimension D (for rectangular hollow sections D is dimension of smaller side)	Less than 165 mm	$0.5 D - 1.5 D$
	165 mm or larger	80 mm and larger
Joint type	Right angle branch as in Fig. 12(A)	Any fillet weld in pipe in above thickness and diameter range for pressure applications

*If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.



NOTE — See 3.14.1 for dimensions of ' t ' and ' D '.

FIG. 12 TEST PIECE FOR FILLET WELD IN PIPE
(BRANCH JOINT FOR PRESSURE APPLICATIONS)

4. SUBMISSION OF TEST WELD

4.1 If the welder realizes that for some reason the test weld he has made is likely to fail the subsequent examination and testing, he may withhold the submission of the test piece and make a second test weld. If the welder does choose to make a second test weld, it is the second test piece that shall be examined and tested, the first test piece being scrapped.

5. EXAMINATION AND TESTING

5.1 Visual Examination — Each test piece shall be examined visually on completion of welding, and before sectioning for destructive testing.

The following points shall be assessed, bearing in mind whether full or toe grinding is to be applied to the production-work on which the welder will be engaged.

5.1.1 Weld Contour — The weld metal shall be properly fused with the parent metal. The weld toes shall blend smoothly with the parent metal.

Fillet welds shall be of approximately equal leg length and free from overlap at the toes. The leg length dimensions shall be as specified for the test and the throat thickness shall be approximately 0.7 times the leg length.

But welds shall show uniform external excess weld metal not exceeding 25 percent of the parent metal thickness or 5 mm whichever is the smaller.

5.1.2 Undercut — Any undercut shall not exceed 10 percent of the material thickness or 1 mm whichever is the smaller.

5.1.3 Smoothness of Joint Where Welding is Restarted — The stop/start position of each run shall merge smoothly and shall show no pronounced hump or crater in the weld surface.

5.1.4 Penetration in Butt Joints without Backing Welded from One Side Only (see Fig. 13) — Where an edge preparation is used there shall be penetration into the root faces but lack of penetration to the full depth of the root faces shall not be the cause for rejection provided that it does not extend for a total length of more than 25 percent of the joint length.

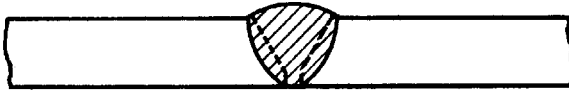
A slight penetration bead may be present, provided that it does not protrude more than 5 mm.

5.1.5 Excessive Penetration in Butt Joints with Backing — The backing material shall not have been pierced due to excessive penetration.

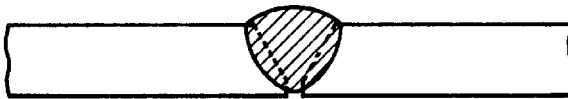
5.1.6 Surface Defects — The weld surfaces shall be free from cracks, porosity and cavities.

5.2 Destructive Tests

5.2.1 Test Specimens — The test pieces produced in accordance with this standard shall always be tested destructively.



(A) ACCEPTABLE



(B) ACCEPTABLE PROVIDED THAT THE TOTAL LENGTH OF INCOMPLETE PENETRATION DOES NOT EXCEED 25 % OF JOINT LENGTH



(C) UNACCEPTABLE IRRESPECTIVE OF LENGTH OF INCOMPLETE PENETRATION BECAUSE OF NO PENETRATION INTO ROOT FACES



(D) UNACCEPTABLE IF PROTRUSION EXCEEDS 5mm

FIG. 13 EXAMPLES OF ACCEPTABLE AND UNACCEPTABLE PENETRATION

The following test specimens are required :

Test 1	1 transverse tensile test specimen 1 macro-section at the stop/start position
Tests 3, 4, 5 and 6	1 transverse tensile test specimen 1 bend test specimen (side or root depending on thickness) 1 macro-section at the stop/start position
Tests 2 and 7	3 fillet weld fracture test specimens, with the end face at the stop/start position used for macro-examination
Tests 8, 9 and 10	1 transverse tensile test specimen 2 root bend test specimens
Tests 11 and 12	4 macro-sections (1 at each crotch and flank)

5.2.2 Transverse Tensile Test — This test is not used to determine the tensile strength of the joint but only to make a qualitative assessment of the fracture surfaces if the fracture takes place at the weld.

For joints without backing welded from one side only, the specimen shall be taken from a location where there is full penetration. For other joints, any backing material shall be removed prior to testing.

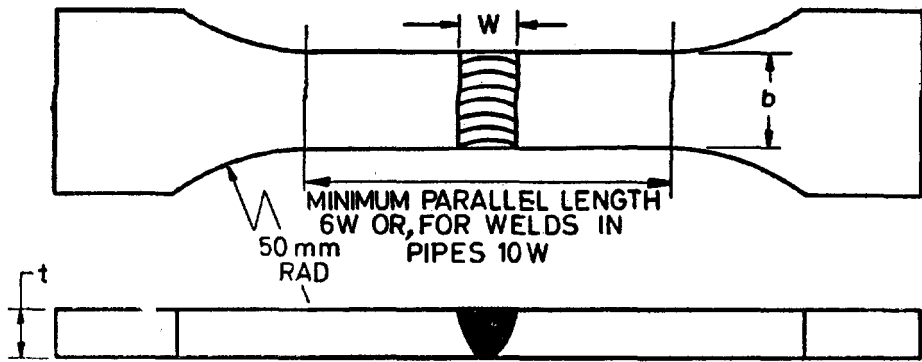
The shape and dimensions of the specimen shall be as indicated in Fig. 14, the width being as given in Table 14. The upper and lower surfaces of the weld shall be dressed flush with the original surface of the material.

TABLE 14 DIMENSIONS OF TRANSVERSE TENSILE TEST SPECIMEN

THICKNESS OF MATERIAL (t)		WIDTH OF SPECIMEN (b)
Over mm	Up to and Including mm	
—	3	12
3	10	20
10	20	25
20	30	40

The specimen shall be tested in tension until fracture occurs, after which the fracture surfaces shall be assessed in accordance with the requirements of 5.2.7.

5.2.3 Macro-Examination — The specimen shall be the full thickness of the material at the welded joint and the excess weld metal and penetration



All dimensions in millimetres.

FIG. 14 REDUCED TRANSVERSE TENSILE TEST SPECIMEN

bead and permanent backing when used shall be left intact. The specimen shall contain a length of the joint of at least 10 mm and shall extend on each side of the weld for a distance that includes the heat-affected zone and some parent metal. For Tests 2 and 7, the end face of the fillet weld fracture test specimen at the stop/start position shall be used for macro-examination before the specimen is fractured.

The face of the specimen containing the weld cross section shall be prepared, polished and etched using an approved method and etching solution (see Appendix B).

The etched face shall be examined visually, in conjunction with a hand lens of magnification not greater than 5 diameters if required.

5.2.4 Side Bend Test (For Plate at Least 10 mm Thick) — For joints without backing welded from one side only, the specimen shall be taken from a location where there is full penetration. For other joints, any backing material shall be removed prior to testing.

The specimen shall be a parallel strip cut transversely to the weld containing a length of the joint of at least 10 mm. The width of the specimen shall be the full thickness of the material at the welded joint and the upper and lower surfaces of the weld shall be dressed flush with the original surface of the material. The edges of the specimen shall be rounded to a radius not exceeding 10 percent of the specimen thickness.

The specimen shall be bent through 180° using only the controlled bend test type of apparatus over a former of a diameter appropriate for the material group (see Table 15) such that the cross section of the weld is in tension.

If the specimen bends through 180° without failure, slight opening-out at the corners or on the tension surface shall not be the cause for rejection.

If the specimen fails across the surface in tension, it shall be broken open and assessed in accordance with the requirements of 5.2.7.

TABLE 15 BEND TEST FORMER DIAMETER

PARENT METAL GROUP NUMBER (See TABLE 1)	FORMER DIAMETER (t IS SPECIMEN THICKNESS)
1	3 t
2	8 t
3	6 t
4	8 t

5.2.5 Root Bend Test (For Plate Less Than 10 mm Thick and for Pipe Butt Weld) — For joints without backing welded from one side only, the specimen shall be taken from a location where there is full penetration. For other joints, any backing material shall be removed prior to testing.

The specimen shall be a parallel strip cut transversely to the weld, its width being at least 30 mm. The specimen shall be the full thickness of the material at the welded joint and the upper and the lower surfaces of the weld shall be dressed flush with the original surface of the material. The edges of the specimen shall be rounded to a radius not exceeding 10 percent of the specimen thickness.

The specimen shall be bent through 180° using only the controlled bend test type of apparatus over a former of a diameter appropriate to the material group (see Table 15) such that the root of the weld is in tension.

If the specimen bends through 180° without failure, slight opening-out at the corners or on the tension surface shall not be the cause for rejection. If the specimen fails across the surface in tension, it shall be broken open and assessed in accordance with the requirements of 5.2.7.

5.2.6 Fillet Weld Fracture Test — The test piece shall be cut to give three test specimens of equal length. Each specimen shall be fractured by bending or by blows applied in the direction indicated in Fig. 2 or Fig. 7. To ensure fracture in the weld a central saw cut approximately 2 mm deep shall be made along the length of the weld surface. The fracture surfaces shall be assessed in accordance with the requirements of 5.2.7.

5.2.7 Assessment of Destructive Tests — The presence of any of the following defects as revealed by, and not due to, destructive testing shall be sufficient cause for rejection unless it can be established that the defects are the result of metallurgical or extraneous causes and are not attributable to the welder's workmanship :

- a) Any type of crack.
- b) Any lack of fusion, except that in Tests 11 and 12 slight lack of root fusion at the flank position shall not be the cause for rejection.
- c) On macro-examination uniform or localized porosity, tungsten and oxide inclusions greater than 3 mm diameter.

For other tests, any oxide or tungsten inclusions or wormholes which in the plane of examination individually have a maximum dimension of more than 3 mm or collectively have a total dimension exceeding 25 percent of the parent metal thickness.

- d) Copper inclusions.

5.3 Repeat Tests — If the test piece fails to meet any of the requirements of 5.1 or 5.2.7, two further test pieces shall be welded and subjected to the same tests. If either of these additional welds does not meet the required standard, the welder shall be regarded as not capable of meeting the requirements of this standard without further training.

6. STATEMENT OF RESULTS

6.1 A statement of the results of assessing each test piece, including repeat tests, shall be made for each welder. The items required under 2 shall be included together with details of any features that would be rejectable by the requirements of 5. If no rejectable features are found, a statement that the test piece made by the particular welder satisfied the requirements of this standard in respect of that type of test weld shall be signed by the person conducting the test.

The welder's employer should hold and regularly maintain adequate records of all approval tests for each welder. A typical record sheet is shown in Appendix A.

If an independent inspecting authority witnesses the welder approval tests carried out in accordance with this standard and all the relevant provisions are fulfilled, it is recommended that such approval should be accepted by others.

7. RE-APPROVAL OF WELDER

7.1 The re-approval of a welder shall be required if any of the following apply :

- a) The welder changes his employer without the transfer of his test records.
- b) Six months or more have elapsed since the welder undertook any welding of aluminium or aluminium alloys.
- c) There is some specific reason to question welder's ability.

APPENDIX A

(Clauses 3.5.1, 3.5.2, 3.6.1, 3.6.2, 3.7.1, 3.7.2,
3.8.1, 3.8.2 and 6.1)

TYPICAL WELDER APPROVAL TEST RECORD

NOTE—One sheet should be completed for each test.

Welders' name*	Welders' identity No.
Approval test No.	Date of test:
Welding process	
Parent material : Group No.	Welding consumables : Filler material specification and diameter
Thickness	Type and size of tungsten electrode where applicable
Pipe outside diameter or dimension	Shielding gas composition and flow rate, purging gas, if any
Welding position	Pipe position
Type of joint and pre-weld cleaning with sketch of weld	Weld dimensions required
	Other factors (welder's choice) e.g. current, voltage, wire-feed speed

Approval Test Results

(State : Satisfactory, unsatisfactory or not applicable)

Visual Examination :

Weld contour

Undercut

Stop/start

Penetration (joints without permanent backing)

Excessive penetration (joints with backing)

Surface defects

Assessment of Destructive Tests :

Cracks

Lack of fusion

Tungsten and oxide inclusions, porosity and wormholes

Copper inclusions

Result of test (passed or failed)

Employer's certifying signature and status of signatory	Date
Inspecting authority's signature (when applicable)	Date

*Both names for 'double operator' technique, for which approval applies only while the welders remain as a team.

APPENDIX B

(Clause 5.2.3)

SUGGESTED METHOD OF PREPARING ETCHED SPECIMENS

B-1. PREPARATION OF SURFACES FOR ETCHING

B-1.1 The initial preparation of a cut surface may be by milling or turning. Alternatively, the surface should be filed with a coarse file until all deep marks are removed. It should then be filed at right angles to the original coarse file marks with a smooth file. The application of chalk to the teeth of the fine file will reduce the risk of surface scoring by metallic particles trapped on the teeth of the file.

The machined or smooth-filed surface is then abraded on successively finer grades of waterproof silicon carbide paper. A suitable sequence of grit sizes is 100, 240, 400 and 600. If the specimen is of suitable size to be conveniently handled, the most satisfactory procedure is to lay the appropriate sheet of abrasive paper, face up, on a flat surface such as plate glass, resin impregnated paper laminate, etc. The abrasive paper is then fabricated either with water, industrial alcohol, or white spirit, and the specimen carefully rubbed on it, with the application of moderate pressure, until all traces of the surface scratching from the previous treatment are removed. The specimen is then washed to remove all traces of abrasive, and the procedure repeated with the next finer grade of abrasive paper, the direction of abrading in each case being at right angles to the marks made by the previous paper.

In cases where the specimen size is such that the above procedure is inconvenient, the abrading may be carried out by employing rotating abrasive disks in a suitable hand tool. This operation will of necessity be carried out dry, and successively finer grit sizes should be used, as in the wet method. Care should be taken to avoid exerting undue pressure on the surface, since this will cause metal to flow over, and obscure any fine porosity which may be present.

A fine-machined surface, produced by sharp tools, with adequate lubrication, is suitable for macro-etching without any further preparation, and the abrading of a filed surface need only be taken as far as 400 grade for a satisfactory etch to be obtained. Such machined surfaces are not, however, in the most suitable condition for the detection of fine porosity, for which purpose it is recommended that abrading down to 600 grade paper should be employed.

B-2. ETCHING FOR MACRO-EXAMINATION

B-2.1 Suitable etchants for welds in pure aluminium and all wrought alloys are the following :

- a) 45 percent by volume of hydrochloric acid ($d=1.16$)
 15 percent by volume of nitric acid ($d=1.42$)
 15 percent by volume of hydrofluoric acid (40 percent *m/m* HF)
 25 percent by volume of water
- b) Sodium hydroxide (100 g/l) for 10–20s, less if warmed, followed by cleaning in nitric acid ($d=1.42$).

NOTE — Care should be exercised in handling these etchants. In particular hydrofluoric acid, even when very dilute, shall not come into contact with finger nails.

Etching is carried out either by swabbing with cotton wool or by immersion. After this treatment wash the specimen in water, blot the surface with filter paper and dry in warm air.

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(Continued from page 2)

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BUREAU OF INDIAN STANDARDS

Headquarters:

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Telegrams : Manaksanstha
(Common to all Offices)

Central Laboratory:

Plot No. 20/9, Site IV, Sahibabad Industrial Area, Sahibabad 201010

Telephone

8-77 00 32

Regional Offices:

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002 323 76 17

*Eastern : 1/14 CIT Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054 337 86 62

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022 60 38 43

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‡Peenya Industrial Area, 1st Stage, Bangalore-Tumkur Road,
BANGALORE 560058 839 49 55

Gangotri Complex, 5th Floor, Bhadbhada Road, T.T. Nagar, BHOPAL 462003 55 40 21

Plot No. 62-63, Unit VI, Ganga Nagar, BHUBANESHWAR 751001 40 36 27

Kalaikathir Buildings, 670 Avinashi Road, COIMBATORE 641037 21 01 41

Plot No. 43, Sector 16 A, Mathura Road, FARIDABAD 121001 8-28 88 01

Savitri Complex, 116 G.T. Road, GHAZIABAD 201001 8-71 19 96

53/5 Ward No.29, R.G. Barua Road, 5th By-lane, GUWAHATI 781003 54 11 37

5-8-56C, L.N. Gupta Marg, Nampally Station Road, HYDERABAD 500001 20 10 83

E-52, Chitaranjan Marg, C-Scheme, JAIPUR 302001 37 29 25

117/418 B, Sarvodaya Nagar, KANPUR 208005 21 68 76

Seth Bhawan, 2nd Floor, Behind Leela Cinema, Naval Kishore Road,
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Patliputra Industrial Estate, PATNA 800013 26 23 05

Institution of Engineers (India) Building 1332 Shivaji Nagar, PUNE 411005 32 36 35

T.C. No. 14/1421, University P. O. Palayam, THIRUVANANTHAPURAM 695034 6 21 17

*Sales Office is at 5 Chowringhee Approach, P.O. Princep Street,
CALCUTTA 700072 27 10 85

†Sales Office is at Novelty Chambers, Grant Road, MUMBAI 400007 309 65 28

‡Sales Office is at 'F' Block, Unity Building, Narashimaraja Square,
BANGALORE 560002 222 39 71